223

J Oral Maxillofac Surg
55:1081-1087, 1997

Surgical Treatment of Fractures of the Edentulous Mandible

GEROLD K.H. EYRICH, MD, DMD,* KLAUS W. GRÄTZ, MD, DMD,† AND HERMAN F. SAILER, MD, DMD‡

Purpose: This retrospective study presents treatment alternatives for fractures of the edentulous mandible.

Methods: A chart review of 34 patients with fractures of the edentulous mandible was performed. Patients were followed with clinical and radiographic examinations.

Results: Five different treatment groups were used, ranging from closed treatment to bone graft augmentation and immediate placement of dental implants. Twenty-five patients showed good bony union. Frequent complications were encountered, including psuedarthrosis, fractured plates, and persistent dysesthesia. Augmentation was more stable when implants were placed simultaneously.

Conclusion: Treatment needs to be based on the type and location of the fracture and the degree of atrophy. Augmentation in combination with implants appears to be a good treatment for fractures of the edentulous mandible.

Treatment of fractures of the edentulous mandible is a special therapeutic challenge. The necessity of an open procedure has been questioned by some authors.[1,2] However, a recent literature review[3] showed that patients with these fractures are now considered good candidates for an open procedure.

Inadequate stability and bone deficiency are very common in the management of fractures of the edentulous mandible. This is primarily because of the limited amount of bone contact between the fractured segments. In addition, severe bone atrophy usually leads to unsatisfactory postoperative denture retention and lack of an adequately adapted lower denture, resulting in low denture use. Obwegeser and Sailer[4] introduced a method that attempted to solve these management problems by simultaneously bridging the defect and augmenting the mandible with split rib bone grafts. This treatment seemed to achieve good results. However, because of late bone resorption, a modification using iliac or calvarial grafts in combination with endosseous implants was used to reduce bone resorption and obtain better functional results by improving masticatory function with implant-borne prostheses.

The goal of fracture management is the restoration of form and function. Edentulous mandibular fracture management should ideally involve not only stabilization through osteosynthesis but also elimination of bony atrophy, making the mandible functionally suitable for dental prostheses. This retrospective study evaluated five methods of edentulous fracture management.

Patients and Methods

A retrospective chart review of 34 patients with fractures of the edentulous mandible treated between 1982 and 1994 was performed. All patients were treated at the Department of Maxillofacial Surgery, University Hospital, Zürich. The mean age of the patients was 70.5 years, with a range from 38 to 89 years. There were nine men (26%) and 25 women (74%). Follow-up periods ranged from 1 to 5 years. Only patients with complete documentation were included in this study.

Received from the Department of Maxillofacial Surgery, University Hospital Zürich, Switzerland.
* Resident.
† Senior Consultant.
‡ Professor and Chairman.
Address correspondence and reprint requests to Dr Eyrich: Department of Maxillofacial Surgery, University Hospital Zürich, Frauenklinikstrasse 10, CH-8091 Zürich, Switzerland.

© 1997 American Association of Oral and Maxillofacial Surgeons
0278-2391/97/5510-0006$3.00/0

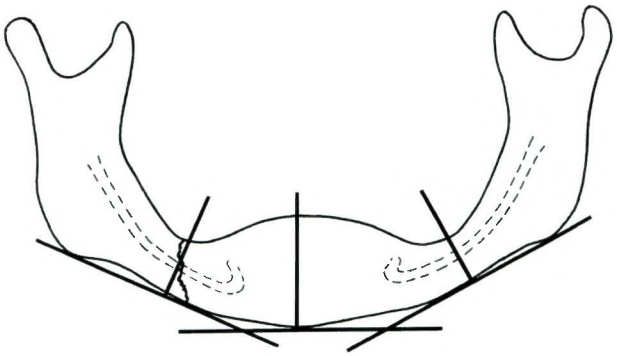


FIGURE 1. Illustration showing how vertical measurements were made at the fracture site or alternatively at the lowest point in the lateral region and anterior midline.

The diagnosis of a totally edentulous mandibular fracture was confirmed by history, physical examination, and radiologic findings. Medical records were reviewed to determine the history of presenting problem, circumstances of the injury, type of fracture, and medical history. Fractures in mandibles with preexisting lesions, such as cysts, or with deficient bone such as progressive osteoporosis, were classified as pathologic.[5] The operative treatment and intraoperative complications were determined from the surgical reports. The postoperative course was documented for at least the first year in all cases.

Radiographs (panoramic and cephalometric) were available preoperatively, immediately postoperatively, and 1 year postoperatively. The amount of atrophy was classified according to Cawood and Howell.[6] Assessment of mandibular height at the fracture site, or alternatively at the lowest point in the lateral region and anterior midline, was performed. Mandibular height was defined as the perpendicular distance from the superior mandibular edge to a line tangential to the inferior mandibular border or at the fracture site (Fig 1). In cases with augmentation procedures, measurements were repeated in all postoperative radiographs for evaluation of resorption.[7,8]

Results

Fourteen patients (41%) had neurologic/psychiatric diseases, and 12 patients (35%) suffered from severe systemic disease processes. Mechanisms of injury included a sudden fall in 22 patients (65%), motor vehicle accident in three patients (9%), personal violence in one patient (3%), and no known cause in eight patients (23%). In 19 patients (56%), there was one fracture (body, 18 (53%); angle, 1 (3%), whereas in the remaining 15 patients (44%) there were multiple locations (bilateral within the body, nine [26%], body and angle, two [6%], body and subcondylar region; four [12%]). Twenty-seven fractures (80%) were displaced.

According to Ezsias and Sugar,[5] a fracture that occurs through a preexisting lesion or in a deficient area of bone is a pathologic fracture. Therefore, eight fractures (23%) were considered to be pathologic (five secondary to tumor treatment; three as a consequence of osteoporosis, malnutrition, or renal failure). In five of these eight cases, endosseous implants were involved in the fracture mechanism.

The average mandibular height in the area of fracture was 11.9 mm. Most fracture sites (63%) had a height between 7 and 12 mm. The measurement of the pathologically fractured mandibles was 20 mm or higher.

The patients were categorized into five treatment groups (Table 1). Group 1 included fractures treated by maxillomandibular fixation (MMF) with a modified prosthesis (n = 3; 8%). In group 2, screws and wires were used in seven cases (18%) with oblique fractures; these were mostly unilateral fractures with sufficient bony architecture. The 11 patients in group 3 (28%) had placement of plates and screws for those fractures in a broad mandibular body, complicated fractures, or those with comminution. In group 4 (5 cases; 11%), mandibles with Class VI atrophy[6] were treated with osteosynthesis by bridging the fracture site with a split-rib bone graft. Group 5 patients (13 cases; 33%) had combined procedures involving augmentation with iliac crest (3 cases), a rib graft (5 cases), calvarial bone (1 case), a microvascular fibula graft (1 case), insertion of endosseous implants (7 cases), or combinations of these methods (Table 2). Group 5 involved patients who had extreme atrophy, pathologic fractures, or complicated fractures.

Six cases received augmentation grafts along with insertion of implants (two in a one-stage procedure, five with secondary insertion), four cases had augmentation and osteosynthesis, in one case osteosynthesis and implantation were performed, and two cases were treated by extensive osteosynthesis with plates, screws, and wires. Except for the fibula grafting, all procedures were performed by an intraoral approach. One of seven patients with implant-borne prostheses died within the second year; however, the remaining six patients had good masticatory function after the second year.

Five patients suffered from an accident twice (repeated trauma in two patients) or required a second intervention (one patient with osteoporosis and one patient with an infected fracture).

Patients were assigned to different classes according to the Cawood/Howell classification[6] for atrophic mandibles. Twenty patients (58%) belonged to Class VI, and six patients (17.6%) were assigned to Class III because of the presence of a pathologic fracture. The

Table 1. Distribution of Treatment Groups Based on Type of Fracture and Degree of Mandibular Atrophy

Category	Atrophy[8]	Type of Fracture	Treatment	Cases (n)
Group 1	Class II-VI	Closed	Wiring of modified prosthesis (MMF)	3
Group 2	Class II-V	Oblique and unilateral	Screws and wires	7
Group 3	Class II-V	Complicated or middle piece	Plates and screws	11
Group 4	Class VI	Uni/bilateral uncomplicated	Split rib procedure	5
Group 5	Class VI and/or	Complicated or pathological	Combination of augmentation, fixation, and implant placement	13

distribution of the remaining classes were as follows: Class II: one patient (3%), Class IV: two patients (6%), and Class V: five patients (14.7%). Fourteen of 34 mandibles were augmented; two patients received a procedure twice. Ten grafts were rib grafts, three were iliac crest grafts, one was a calvarial graft, and one was a microvascular fibula graft. One patient received a hydroxylapatite implant.

An investigation of the mandibular height after augmentation with split rib bone grafts clearly showed resorption of nearly 50% in the lateral aspect within the first year and another 45% in the anterior mandible after 2 years (Fig 2). Comparison of split-rib bone grafting procedures with other augmentation procedures showed greater resorption with the split-rib bone grafting technique (Fig 3). After endosseous implant insertion, the resorption rate was one-third less than in patients without implants (Fig 4). However, because the number of patients shown in Figures 2 through 4 was small, statistics were not applied.

Postoperative complications were common. Five patients (14.7%) developed a pseudarthrosis (two required a second operation, whereas three patients showed bony consolidation without any further treatment). Five of 12 plates removed (three miniplates, two microplates) were found to be fractured, but only three of five fractured plates could be detected on the radiographs. Signs of inflammation or partial bone necrosis were found in seven (20.5%) of the patients. Twenty-five patients (73.4%) showed primary healing and good bony union. Seven patients with no preoperative sensory deficits suffered from a postoperative dysesthesia in the lower lip. These patients had complete spontaneous recovery within the first year. In patients with preoperative dysesthesia (28 mental nerves) resulting from the fracture, dysesthesia was still present in 75% of these nerves (21) at the last examination. One of 20 implants (5%) was removed within the follow-up period.

Table 2. Fracture Management in Group 5 Cases

Group 5 (n = 13)	No. of Cases
Augmentation and implants	6
Implants with osteosynthesis	1
Augmentation and osteosynthesis	4
Combined osteosynthesis	2

Discussion

Long-term edentulous mandibles develop severe bone resorption and alveolar atrophy. Most patients (97%) in our series had fractures in the lateral aspect of the mandibular body. Measurement of mandibular height in the fracture sites on a panoramic radiograph clearly showed 10 mm as a critical mark; this is comparable to other studies and investigations.[9]

Various techniques have been described for the treatment of fractures of the edentulous mandible. These techniques have been modified over the years,

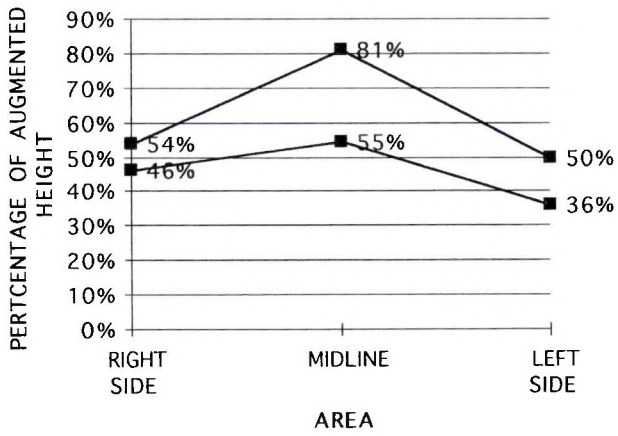


FIGURE 2. Average height of split rib grafts in the lateral and the anterior mandible in percentage of original height (1 year and 2 years postoperatively). (Upper line, 1 year [N = 10]; lower line, 2 years [N = 6].)

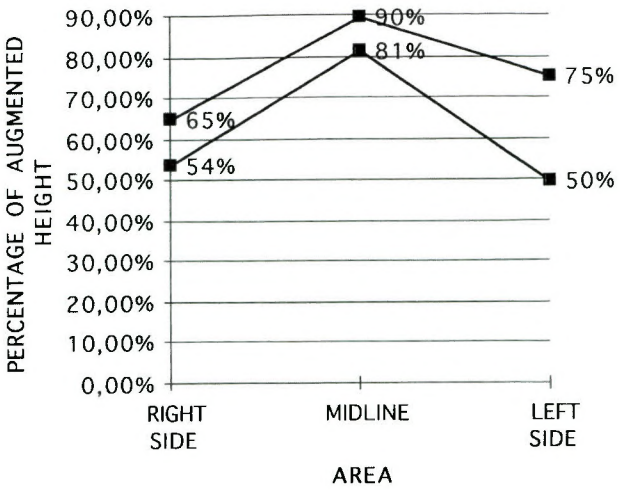


FIGURE 3. Average height of split rib grafts and cranial or iliac bone grafts in the lateral and the anterior mandible in percentage of the original height 1 year postoperatively. (Lower line, split ribs [N = 10]; upper line, iliac or calvarial bone [N = 4].)

but the principles of fracture management have remained unchanged. The basic principles in fracture treatment are reduction and immobilization for restoration of form and function.[3] Immobilization techniques using osteosynthesis can be achieved by numerous devices, plates, wires, screws, external pin fixation, or wiring of a modified prosthesis (MMF). Wires provide good results in uncomplicated unilateral fractures with low-grade atrophy.[10] Thaller[11] believed that it would be extremely important to use the smallest available plate, whereas Bruce and Ellis[12] preferred plates of greatest rigidity. The fact that we found 5 of 12 miniplates removed to be broken supports the suggestion that osteosynthesis exclusively with plates is not always sufficient (various types of plates were used in this study). Merten and Wiese[9] reported excellent results with axial compression osteosynthesis. Lag screws can be used in situations when both cortices can be engaged. The choice of osteosynthesis is based on the type of fracture and the condition of the surrounding tissues.

In most situations, osteosynthesis of the fracture sites in the edentulous mandible does not satisfy the demand for restoration of form and function. To provide good masticatory function with a prosthesis postoperatively, there is a great need for sufficient bony height in the mandible. Obwegeser and Sailer[4] recognized the dilemma of either inadequate stability or insufficient bony height with conventional procedures. In 1973, they introduced the idea of augmentation and simultaneous stabilization of fractures of the edentulous mandible using bone grafts and circummandibular wires along with a modified split-rib procedure.[4] In situations of severe atrophy, augmentation with bone grafts should be considered. Sailer[13] mentioned that, even in cases of severe atrophy, placement of screws or miniplates between the upper ridge and the lower border without damage of the mandibular nerve is sometimes impossible.

Eleven of 14 patients (79%) who received an augmentation procedure showed a radiologic bony height less than 10 mm in the panoramic radiographs. Rib grafts have higher resorption rates than other bone grafts. The use of implants reduced bone loss in the postoperative period. As early as 1960, Thoma[14] reported surgical treatment of an edentulous mandibular fracture with rib grafting and consecutive implantation in a four-step operation. Unfortunately, the implant materials from that period could not stand the test of time.

There is no clear answer concerning whether immediate implantation leads to less bone resorption or an exposure of implants by bone loss. Loss of implants in only 5% of these cases is an excellent result. Grätz et al[8] showed good results with the sandwich procedure in combination with titanium screw implants, as described by Sailer[15] in nonfractured atrophic mandibles. Therefore, the sandwich procedure also was used in trauma cases if mandibular height was insufficient (Figs 5-7). Osteosynthesis, augmentation, and implantation of dental implants can be performed simultaneously with a vestibuloplasty (Fig 7B).

Surgical treatment can be complicated or even questionable in patients afflicted with severe disease processes. The mean age in our study was 71 years. Considering the physiologic changes of aging, and the fact

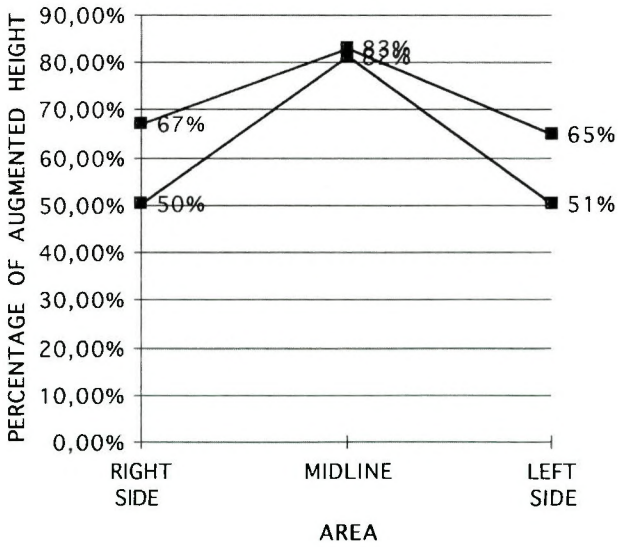


FIGURE 4. Average height of bone grafts with and without implants in percentage of the original height in the lateral and the anterior mandible (1 year postoperatively). (Lower line, no implants [N = 8]; upper line, implants [N = 6]).

that pathologic conditions occur with a higher prevalence in older patients, problems arising from general anesthesia and impairment of wound healing are easily understood. If the status of the patient does not allow an open reduction then a modified prosthesis is advisable, especially in the case of pathologic fractures, where the basic disease process directly affects the local situation, thus requiring individualized treatment strategies. In the case of bone-invading processes, fracture treatment is secondary to elimination of the underlying cause. Fractures in patients with generalized bone destruction require stable fixation with the highest rigidity. In this study, one patient required a microvascular graft because of bone necrosis at the fracture site caused by a pathologic fracture. Another remarkable finding in this study was that in five of eight cases implants were involved in the fracture mechanism. Seven patients suffered from postoperative dysesthesia in the lower lip after surgery, but all of them recovered within the first year. By investigating the postoperative course of preoperatively developed nerve disturbances, we found that 75% of the dysesthesias did not disappear during our follow-up period.

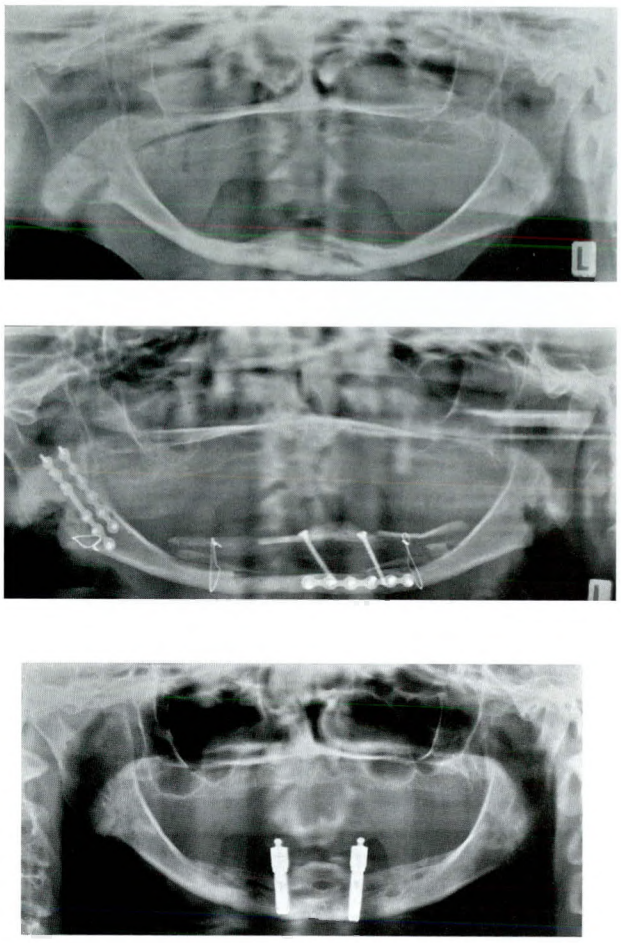


FIGURE 5. Panogramic radiographs of a 55-year-old women with an oblique paramedian body fracture on the right and an angle fracture on the left side (*A*, preoperative; *B*, immediately after osteosynthesis and augmentation with a sandwich procedure; *C*, 6 months after implantation of 2 Brånemark implants).

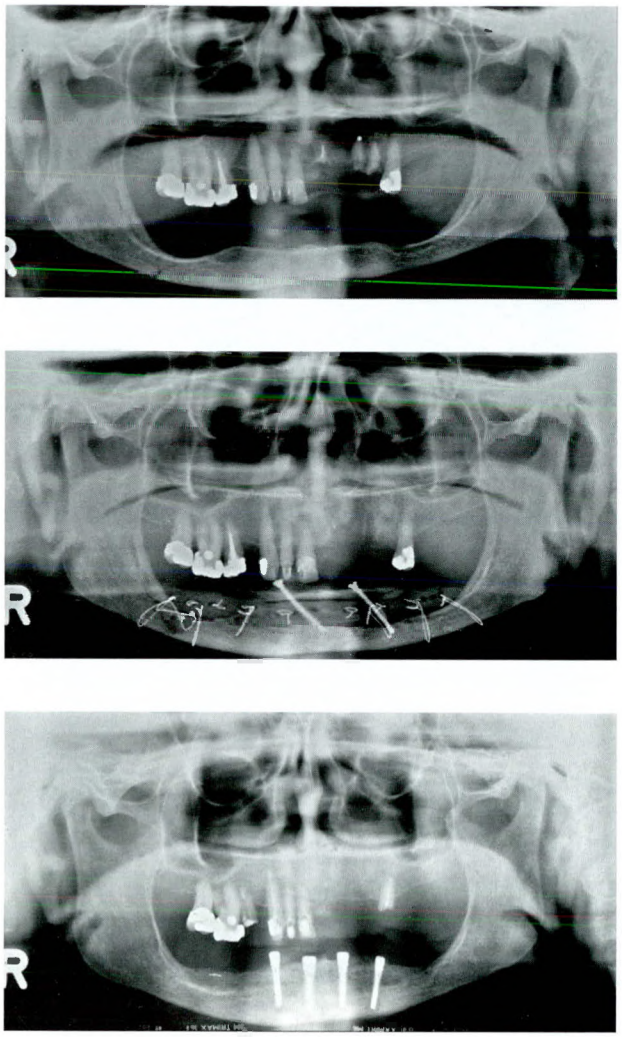


FIGURE 6. Panogramic radiographs of a 76-year-old woman with a middle piece corpus fracture on the right side (*A*, preoperative; *B*, immediately after osteosynthesis and augmentation; *C*, 6 months after implantation of 4 HATI implants).

The incidence of pseudarthrosis (14.7%) or fibrous nonunion is in agreement with rates (15% and 20%, respectively) reported by Bruce and colleagues[12,16] when different types of treatment were used. In three of the five patients with pseudarthrosis, we found bony consolidation after 3 to 5 months without further treatment except removal of exposed plates and screws. Twenty percent of patients in this study developed signs of inflammation. Levine[17] reported a 26% incidence of infection when using eccentric compression plates. Fewer cases of fibrous nonunion and infection were reported when pathologic fractures were not in-

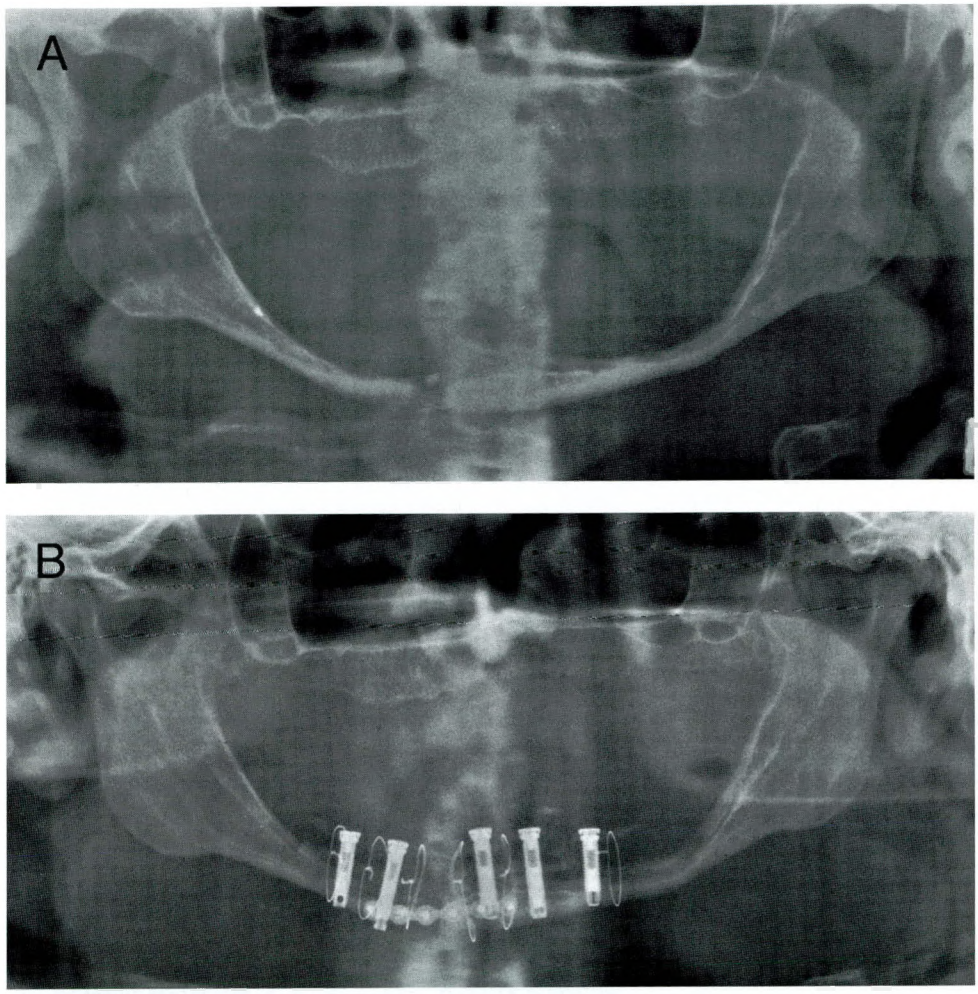


FIGURE 7. Panogramic radiographs of a 65-year-old man with an infected (4 weeks after trauma) body fracture. *A*, Preoperative view; *B*, An onlay augmentation with iliac crest bone and simultaneous implantation of five Brånemark implants.

cluded and only one type of treatment was used[9,10,17] or the patients had a much lower average age.[11,18,19] In addition, complication rates increase with the number of old infected fractures[10] or displacement of the fracture site. Three of five patients with pseudarthrosis were operated on more than 4 weeks after injury. Another fibrous nonunion occurred in a patient with osteoradionecrosis.

Mild signs of inflammation were often seen when wires were exposed (five patients), but these cases needed no further surgical treatment except wire removal. Three cases with abscess formation required further surgical procedures. Overall, considering that our series included eight pathologic fractures, seven infected fractures older than 4 weeks, and an average patient age of 71 years; the results were acceptable. The recommendation of Bruce and Ellis[12] and Newman[19] that more aggressive treatment such as immediate grafting leads to improved results is also supported by our study.

Based on the results of this study, the following surgical approaches are recommended:

1. Wiring of a modified prosthesis (MMF) in inoperable patients with closed fractures
2. Osteosynthesis with lag screws or, alternatively, with plates in oblique unilateral fractures in mandibles with Class I to V atrophy
3. Osteosynthesis with plates in comminuted or complicated fractures in mandibles with Class I to V atrophy
4. A combination of augmentation, fixation, and implants in mandibles with Class VI atrophy or complicated or pathologic fractures (eg, the sandwich procedure with autogenious illiac crest bone and implant insertion)

References

1. Allard RKS, Lekkas C: Unusual healing of a fracture of an atrophic mandible. J Oral Surg 55:560, 1983
2. Zachariades N, Papavassiliou D, Tirantafyllou D, et al: Fractures of the facial skeleton in the edentulous patient. J Oral Maxillofac Surg 12:262, 1984
3. Buchbinder D: Treatment of fractures of the edentulous mandible, 1943 to 1993. J Oral Maxillofac Surg 51:1174, 1993

4. Obwegeser HL, Sailer HF: Another way of treating fractures of the atrophic edentulous mandible. J Maxillofac Surg 1:213, 1973
5. Ézsiás A, Sugar AW: Pathological fractures of the mandible: A diagnostic and treatment dilemma. Br J Oral Maxillofac Surg 32:303, 1994
6. Cawood JI, Howell RA: Reconstructive preprosthetic surgery. I. Anatomical considerations. Int J Oral Maxillofac Surg 20:75, 1991
7. Farmand M, Ryffel M: Results after mandibular ridge augmentation with laminated split ribs, pedicled anterior bone lid and simultaneous sulcoplasties. J Craniomaxillofac Surg 15:141, 1987
8. Grätz KW, Sailer HF, Oechslin CK: Results after interforaminal mandibular sandwich procedure in combination with titanium screw implants. Oral Maxillofac Surg Clin North Am 6:689, 1994
9. Merten H-A, Wiese KG: Frakturen des zahnlosen, atrophischen Unterkiefers. Dtsch Z Mund Kiefer Gesichts Chir 16:144, 1992
10. Freihofer HP, Sailer HF: Experiences with intraoral trans-osseous wiring of mandibular fractures. J Maxillofac Surg 1:248, 1973
11. Thaller SR: Fractures of the edentulous mandible: A retrospective review. J Craniofac Surg 4:91, 1993
12. Bruce RA, Ellis E III: The Second Chalmers J. Lyons Academy Study of Fractures of the Edentulous Mandible. J Oral Maxillofac Surg 51:904, 1993
13. Sailer HF: Therapiekonzepte der spontanen Unterkieferfrakturen. Dtsch zahnärztl Z 38:426, 1983
14. Thoma KH: Progressive atrophy of the mandible complicated by fractures: Its reconstruction. Oral Surg 13:4, 1960
15. Sailer HF: Neue Methoden zur oralen Rehabilitation. Swiss Dent 10:23, 1991
16. Bruce RA, Strachnan DS: Fractures of the edentulous mandible: The Chambres Lyons Academy study. J Oral Surg 34:973, 1976
17. Levine P: Treatment of fractures of the edentulous mandible. Arch Otolaryngol 108:167, 1982
18. Amartunga NA de SA: Comparative study of the clinical aspects of edentulous and dentulous mandibular fractures. Oral Surg Oral Med Oral Pathol 46:3, 1988
19. Newman L: The role of autogenous primary rib grafts in treating fractures of the atrophic edentulous mandible. Br J Oral Maxillofac Surg 33:381, 1995